GUNNISON RIVER / ASPINALL UNIT TEMPERATURE STUDY - PHASE I

EXECUTIVE SUMMARY

PREPARED FOR:

UPPER COLORADO RIVER ENDANGERED FISH RECOVERY PROGRAM

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HYDROSPHERE
Resource Consultants

1. INTRODUCTION

Hydrology of the Gunnison basin has been significantly altered by the construction and operation of the Aspinall Unit (Blue Mesa, Morrow Point and Crystal Reservoirs), numerous other smaller reservoirs, and diversion and return flow features related to irrigation in the basin, particularly in the areas surrounding Montrose and Delta. Cold-water releases from the Aspinall Unit reservoirs have been identified as a significant impediment to re-establishment of pikeminnow habitat in the Gunnison River near Delta (Osmundson, 1999). Results of Osmundson's work indicate that increasing mean water temperatures at Delta by 1 ^{o}C in June, September and October, and by 2 ^{o}C in July and August, would increase the mean annual thermal units (ATU) from 32 to 46 units. Such an increase would put stream temperatures at Delta at a level similar to sites on the Yampa and Colorado Rivers which have abundant populations of pikeminnow.

The objective of this phase I study was to determine the feasibility of increasing stream temperatures in the Gunnison River at and below Delta, Colorado through structural and / or operational modifications to the Aspinall Unit reservoirs. The project is being approached in a two-step process. The first phase of the work, which this report summarizes, includes: data collection and assessment; an overview of factors that may constrain the Program's ability to meet temperature objectives; a cursory analysis of the data with the intent of gaining insight into the primary physical processes governing water temperature in the basin; and modeling recommendations for the second phase of the work.

Phase II of the project, if approved, would involve development of numerical models of both the Aspinall reservoirs and the Gunnison River downstream. The objective of phase II would be to use these models to simulate temperatures in the river / reservoir system under a variety of Temperature Control Device options and flow regimes.

2. RESULTS AND RECOMMENDATIONS

We must stress that the results presented here are based on a preliminary analysis of the available data. We strongly recommend that a rigorous modeling effort be undertaken, with a particular focus on how thermal regimes in the three Aspinall reservoirs could change with installation of a temperature control device (TCD).

The results of phase I of the Gunnison River / Aspinall Unit Temperature Study indicate that Aspinall Unit construction and operation has had a significant impact on water temperatures at Delta, and that warmer release temperatures during the summer would in most cases translate into warmer temperatures in the river near Delta. The findings also indicate that a TCD on Blue Mesa Dam is likely to be the best approach to achieving warmer releases from Crystal Dam. Although modified annual flow patterns have also impacted water temperatures at Delta, complications arising from physical and institutional constraints would severely limit the effectiveness of a flow-based temperature management approach.

Data Collection. An extensive data collection program was completed during the summer of 2001. Much of the data required to conduct model development and calibration during phase II of the project were obtained. These data include meteorological, hydrological, and water temperature time series data, as well as physiographic and engineering data pertaining to reservoirs, dams, and river reaches. Based on a review of the data, no additional field work was conducted during 2001. We did however recommend to George Smith of the FWS that temperature recording devices be placed at least temporarily near the mouths of the Uncompahgre and North Fork of the Gunnison Rivers to provide additional baseline data on tributary inflow temperatures. Additionally, one or more temperature recording devices on the mainstem of the Gunnison and certain major tributaries above Blue Mesa Reservoir (e.g., Lake Fork, Cebolla, Willow, etc.) would be useful for development and calibration of a Blue Mesa temperature model.

Data Analysis. The primary objective of phase I of this project was to determine whether or not modifications to the Aspinall Unit could result in warmer water temperatures downstream near Delta. Before undertaking a substantial model development program, the Recovery Program asked that we undertake a preliminary analysis of the data with the purpose of 1) providing a preliminary analysis of whether or not increased water temperatures are possible with reservoir modifications, and 2) what type(s) of modeling approach is most appropriate given the nature of the Gunnison system. Our scope for phase I was limited to some straightforward processing of data for visualization and preliminary statistical analyses. Nevertheless, the following conclusions can be drawn:

1. Stream temperatures near Delta are significantly impacted by Aspinall operations, and do not return to ambient conditions until somewhere downstream of Delta.

2. Blue Mesa Reservoir is the primary cause of cold-water releases from the Aspinall Unit. Crystal releases are warmer than those of Blue Mesa, indicating that Morrow Point and Crystal actually warm the river relative to Blue Mesa release temperatures.

3. Warmer water is physically available in Blue Mesa, and could be released downstream with a TCD. Models of all three reservoirs would be useful in determining the impacts of such a structure on the thermal regimes of the reservoirs.

4. Tributary inflows do impact stream temperatures at Delta, but not with a frequency or magnitude to render potential reservoir control ineffective.

5. Warmer releases from Crystal would result in warmer river temperatures at Delta. Generally, release temperatures from Crystal would need to be increased about 3 ^{o}C to warm the river at Delta by 2 ^{o}C.

6. Stream temperatures at Delta show a strong statistical correlation to release temperatures and atmospheric conditions; thus, a statistical model could potentially be used in lieu of a more costly physically-based model of the river.

Constraints. We focused this work predominantly on questions of whether or not it would be physically possible to obtain warmer stream temperatures near Delta through operational or structural modifications to the Aspinall Reservoirs. However, a significant consideration of any proposed change to the system would necessarily involve non-physical factors including (but not limited to) lost hydropower revenue, state and federal reserved water rights, interstate and international compacts, minimum instream flows, recreational impacts, and capital costs. A summary of these and other constraints was compiled through numerous conversations with local, state, and federal agency personnel and other parties with an interest in the Recovery Program. A description of the constraints and their potential impacts on the Program's ability to control water temperatures are provided in the report.

Modeling Recommendations. Based on the data analysis, we strongly recommend modeling all 3 Aspinall reservoirs, using QUAL-W2, and a multi-variate statistical model of Gunnison River temperatures. Stratification of Morrow Point and Crystal Reservoirs is complicated by hypolimnetic inflows from Blue Mesa, and a mechanistic model is needed to predict changes in stratification due to a TCD.

Results from these model outputs in phase II would answer several questions, including:

1. Would a TCD at Blue Mesa result in warmer release temperatures at Crystal?

2. If so, how much warmer would they be?

3. Would these warmer release temperatures translate into warmer river temperatures in the area around Delta?

4. What are the benefits of a fixed versus variable height withdrawal structure?

5. How would a TCD impact the thermal structure of the Aspinall reservoirs?